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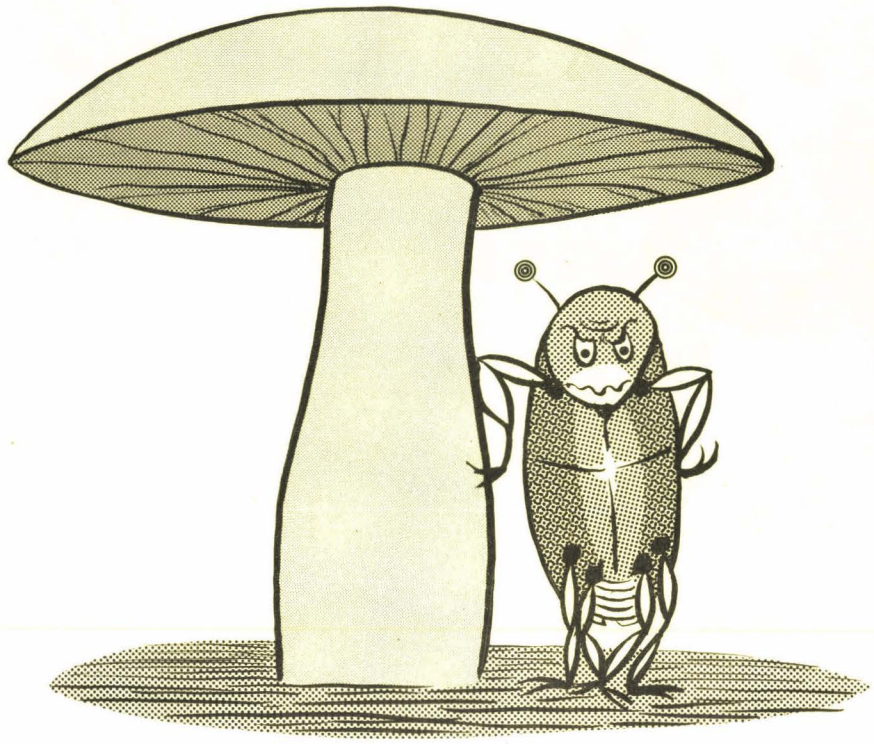
FOREST INSECT and DISEASE CONDITIONS

Northern Region

1972



U. S. DEPARTMENT OF AGRICULTURE – FOREST SERVICE
DIVISION OF STATE AND PRIVATE FORESTRY

REPORT NO. 73–1

MISSOULA, MONTANA 5280

FOREWORD

Our Forest Insect Conditions Report and Forest Disease Conditions Report have been issued separately for many years. This year we have combined the two reports to provide the resource manager with a more complete picture of insect and disease problems.

We gratefully acknowledge all Federal, State, and private agencies whose assistance and cooperation made this report possible. Special thanks go to William M. Ciesla, entomologist; Ralph E. Williams and Clinton E. Carlson, plant pathologists; and Carma J. Gilligan, biological technician, for assistance in compiling this report.

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STATUS OF FOREST INSECTS

CONDITIONS IN BRIEF

Western spruce budworm defoliation was apparent on 4.6 million acres of Douglas-fir and true fir stands in the Region. A damage survey showed extensive permanent injury (top kill and/or tree mortality) is resulting in areas where budworm infestations have persisted for 3 or more consecutive years. Over 138,000 acres of permanent injury was identified on the Nezperce National Forest, Idaho. Larch casebearer populations remained at about the same level as the past 4 years, with heavy defoliation occurring in the lower elevations of eastern Washington, northern Idaho, and near Flathead Lake, Montana. The pine butterfly outbreak increased from about 9,000 acres in 1971 to near 70,000 acres in 1972. Damage intensified to the point that large acreages of ponderosa pine are nearly completely defoliated. A western hemlock looper infestation was detected in Idaho. This is the first report of this insect becoming epidemic in the Region since 1938. Douglas-fir tussock moth activity seems to be increasing, primarily in northern Idaho.

The massive Douglas-fir beetle epidemic in the North Fork Clearwater River drainage in northern Idaho continued, but at a level lower than in 1971. Epidemics of mountain pine beetle continued in western white pine in northern Idaho, in ponderosa pine in western Montana, and in lodgepole pine in Yellowstone National Park and adjacent Gallatin National Forest. Control by thinning young stands of ponderosa pine appears to be successful. Pine engraver infestations have decreased except in localized areas.

MAJOR DEFOLIATOR PROBLEMS

Western spruce budworm, *Choristoneura occidentalis* Free.--Western budworm activity continued to increase in the Northern Region. Aerial surveys revealed 4.6 million acres of defoliation in 1972 (Fig. 1).

Most areas of budworm activity increased in size or remained static (Table 1). The most significant increases of budworm activity were on the Bitterroot and St. Joe National Forests. Most of the upsurge on the Bitterroot was on the Magruder Ranger District, an area where budworm activity had been declining since 1966. The infestation on the St. Joe National Forest is enlarging at an alarming rate. It first became apparent in 1968 when 2,000 acres of defoliation were detected. It has now spread to over 66,000 acres in the past 5 years. Considerable top kill is now occurring, especially in the true firs (Fig. 2).

A damage survey was flown on the Nezperce National Forest in 1972, and areas containing aerially visible permanent injury; i.e., top kill or tree mortality, were mapped. Over 138,000 acres of permanent injury were detected. Most of this injury was in subalpine and grand fir.

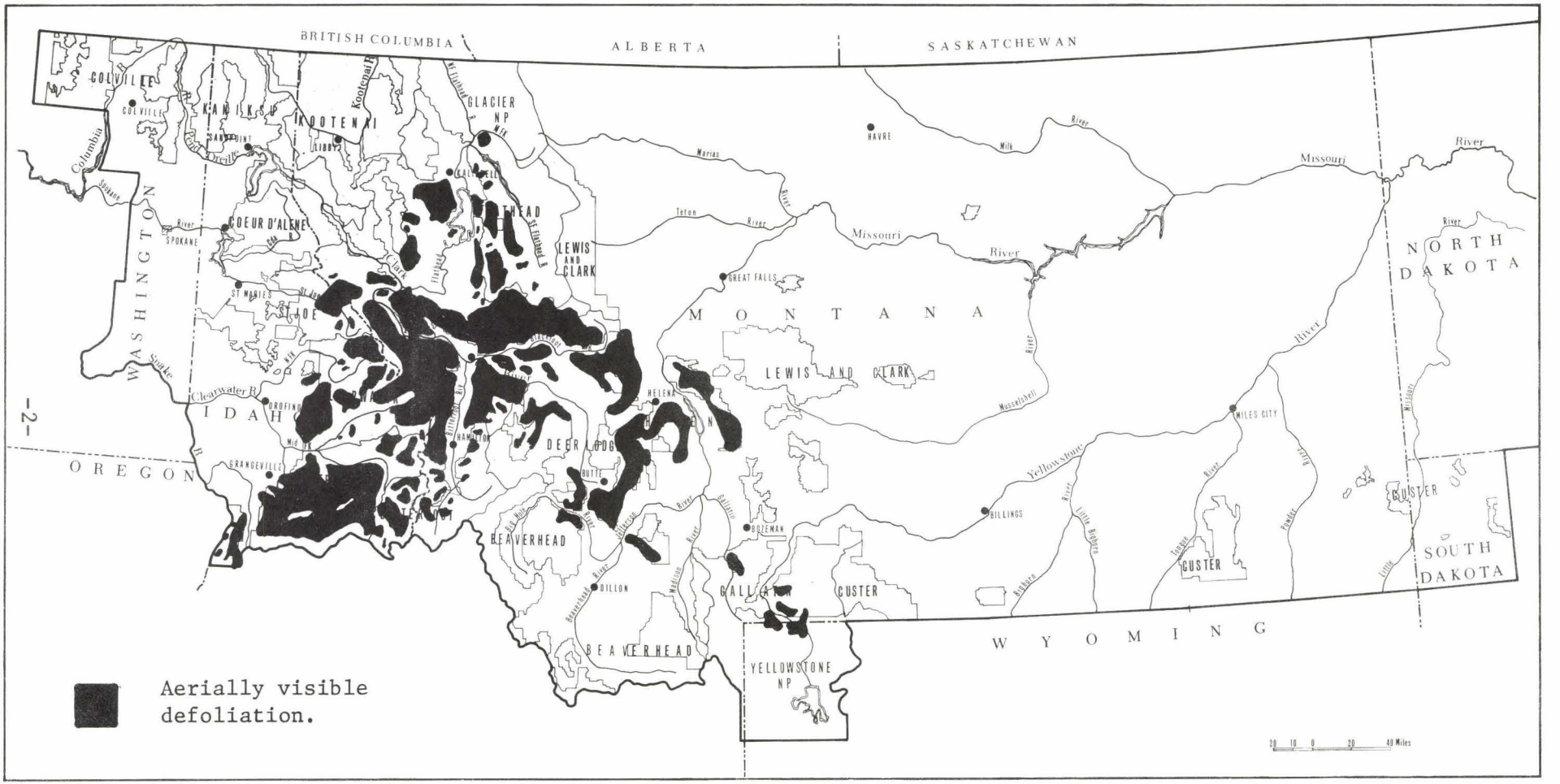


Figure 1.--Aerially visible defoliation by western spruce budworm, 1972.

Table 1.--Acres of aerially visible budworm defoliation in Region 1, 1972

Unit	Defoliation (acres) 1971	1972
Idaho		
Nezperce NF	1,337,000	1,342,000
Clearwater NF	378,000	397,600
St. Joe NF	42,500	66,500
Montana		
Lolo NF	1,260,000	1,350,000
Helena NF	337,280	385,000
Deerlodge NF	285,680	335,000
Bitterroot NF[1/]	175,000	321,000
Flathead Indian Reservation	194,000	195,500
Flathead NF	167,000	188,000
Yellowstone National Park	46,080	46,000
Beaverhead NF	15,000	21,000
Gallatin NF	15,260	15,260
Total	4,252,800	4,641,600

1/ Includes a portion of Idaho.

The impact of budworm on regeneration was recognized to be very significant. Not only do the budworm destroy cones, but they also place the trees under such stress that cones are not produced. Some Forests, specifically the Lolo and Clearwater, have not been able to collect seed for regeneration in budworm-damaged areas. As a result, some cutover areas will remain unstocked for longer periods of time than desired.

Figure 2.--Top kill due to continued defoliation by western spruce budworm.

Larch casebearer, *Coleophora laricella* (Hbn.).--This introduced defoliator of western larch is now established throughout the western larch type in the Northern Region. Population intensities are about the same as have been reported since 1968, with high levels occurring at lower elevations in eastern Washington, northern Idaho, and near Flathead Lake in Montana. Damage has intensified considerably over past years in the Swan Lake Valley, Flathead National Forest, Montana. Though casebearer populations are high in many areas, no significant permanent injury (branch dieback or tree mortality) was observed in 1972.

The casebearer parasite, *Agathis pumila* (Ratz.), was introduced in the Northern Region in 1960 as an attempt to control the outbreak biologically. Since then *A. pumila* have been released at 370 locations in the Region. Collections in 1972 revealed that this parasite was established at least in 80 of the 172 areas checked. Though it is now widespread throughout the Region, it has not to date given the control of the casebearer that was hoped for.

Two new species of casebearer parasites, *Dicladocerus westwoodii* Westwood and *Chrysocharis* sp., were released in Region 1 in 1972. This was done in cooperation with the Pacific Northwest Forest and

Range Experiment Station and the Intermountain Forest and Range Experiment Station. Additional releases of these parasites are planned for future years.

Pine butterfly, *Neophasia menapia* (Felder and Felder) (Fig. 3).--Pine butterfly infestations mushroomed in 1972. The outbreak on the Bitterroot National Forest increased from 4,600 acres in 1971 to about 40,000 acres in 1972. The infestation on the Nezperce National Forest increased from 4,200 acres in 1971 to about 30,000 acres in 1972. Smaller outbreaks occurred on the Lolo National Forest, National Bison Range near Ravalli, Montana, and on the Flathead Indian Reservation. Many of the trees are entirely defoliated and appear almost dead in areas of greatest feeding intensity.

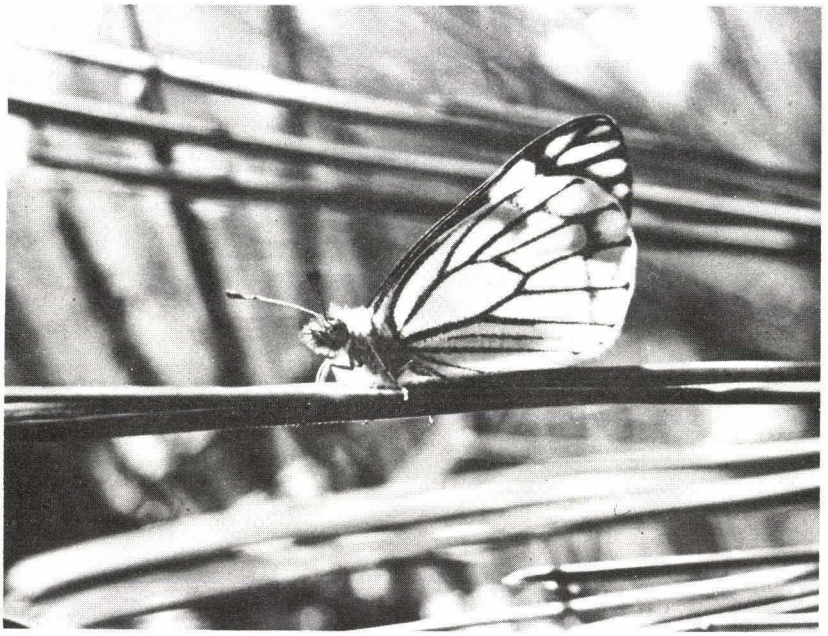


Figure 3.--Pine butterfly on ponderosa pine.

The overwintering egg mass survey indicates the infestation will persist for at least another year. Egg counts have decreased somewhat from 1971, but predicted defoliation is high because the trees have much less remaining foliage than they did a year ago.

The parasite-predator complex is rapidly increasing in numbers. Estimates are that parasitism exceeds 50 percent at some locations. Predation accounts for the death of many butterfly eggs, larvae, and pupae (Fig. 4).

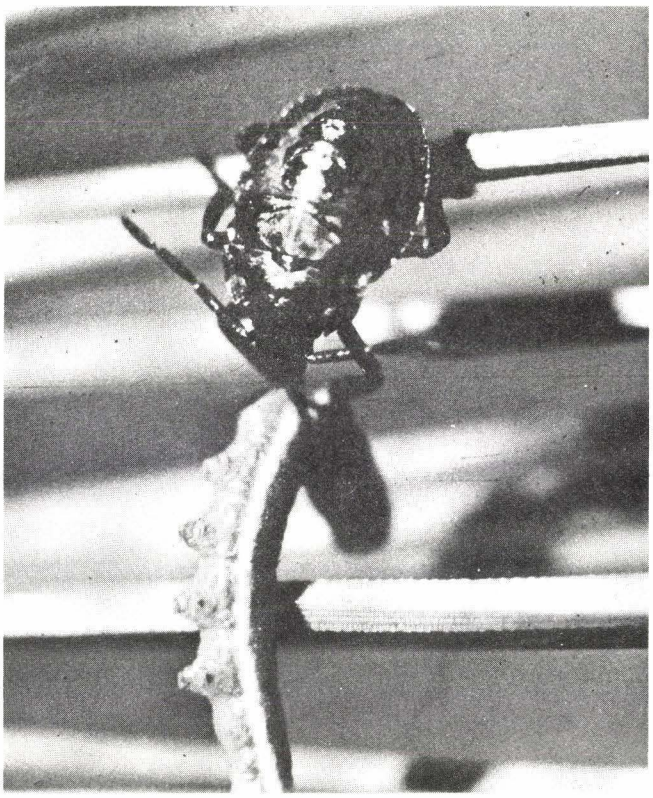


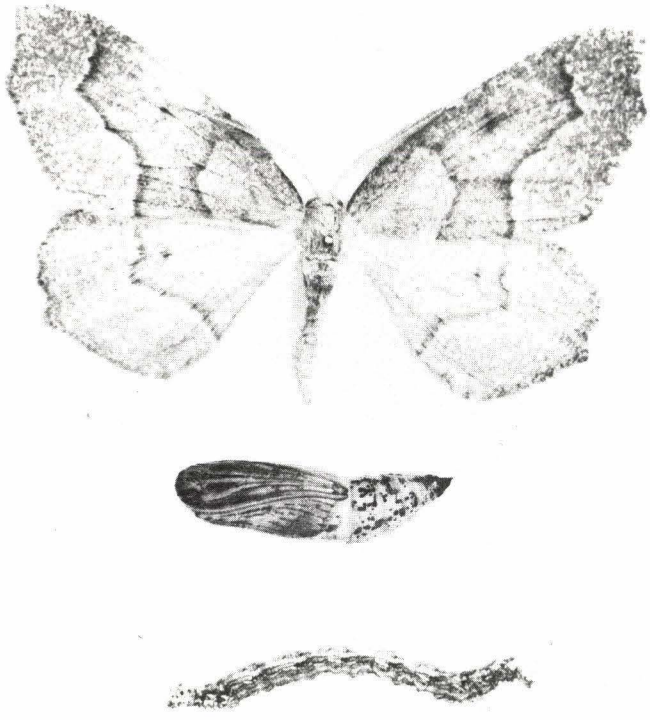
Figure 4.--Predator, *Apateticus bracteatus* (Fitch) feeding on pine butterfly larva.

Douglas-fir tussock moth, *Hemerocampa pseudotsugata* McD.--Localized infestations continued in shade and ornamental trees in 12 locations within the city limits of Coeur d'Alene, Idaho. Additional localized damage was reported in forested areas east of this community. Ornamental trees were reported damaged on private property near Troy, Idaho. Douglas-fir tussock moth egg masses were abundant within a 100-acre logging unit near Charles Butte on the St. Joe National Forest. Noticeable defoliation is expected in this area in 1973.

Approximately 300 acres of Douglas-fir suffered moderate to heavy defoliation on private lands south of Kettle Falls, Washington. Localized activity also occurred in Spokane and Penix Canyon near the Columbia River in northeastern Washington.

It is expected that Douglas-fir tussock moth activity will increase in 1973.

Western hemlock looper, *Lambdina fiscellaria lugubrosa* Hulst (Fig. 5).--Over 10,000 acres of aerially visible western hemlock looper defoliation was detected in 1972. This is the first documented report of this insect's activity in the Region since 1938. The 1938 infestation was reported to have covered several hundred thousand acres and killed up to 60 percent of the stems in the more severely defoliated stands.



The current defoliation is restricted to mature grand fir stands on the St. Joe National Forest, Idaho, and adjoining State and private lands.

Flights of western hemlock looper moths were conspicuous as far north as Coeur d'Alene in northern Idaho, indicating that this insect may cause additional damage in 1973.

A survey of the overwintering egg population is currently underway to try to predict next year's looper activity.

Figure 5.--Western hemlock looper larva, pupa, and adult (bottom to top).

Pine looper, *Phaeoura mexicanaria* (Grote).--The pine looper infestation in the Long Pine and Ekalaka Hills of eastern Montana has greatly declined in 1972. Trees that were red in 1971 have "greened up" remarkably in 1972. Only occasional tree mortality resulted from the epidemic.

The entire looper population did not collapse, for larvae were numerous enough to make collection easy, but scarce enough to cause no detectable defoliation. Parasites and disease were common. It is predicted the infestation will stay down next year.

Miscellaneous defoliators.--Sugar pine tortrix, *Choristoneura lambertiana* (Busck), defoliation was conspicuous on lodgepole pine on the Flathead National Forest. Much of this seems to be associated with the areas of high atmospheric fluoride levels near the aluminum reduction plant at Columbia Falls. The most severe damage is in the form of top kill, resulting in multiple leaders in lodgepole reproduction.

The variable oak leaf caterpillar, *Heterocampa manteo* (Dbldy.) infestation in North Dakota has declined from 4,510 acres of aerially

visible defoliation in 1971 to 1,360 acres in 1972. No permanent injury has been attributed to the infestation to date.

Heavy defoliation was caused by the spring cankerworm, *Paleacrita vernata* (Peck), to Siberian elm shelterbelts of North Dakota. Most extensive damage occurred in the eastern portion of the State.

The forest tent caterpillar, *Malacosoma disstria* Hubner has caused heavy defoliation on a mixture of hardwoods throughout much of North Dakota the past few years. Its activity was greatly reduced in 1972.

MAJOR BARK BEETLE PROBLEMS

Douglas-fir beetle, *Dendroctonus pseudotsugae* Hopk.--The massive epidemic of Douglas-fir beetle in the North Fork Clearwater River of northern Idaho continued in 1972 but at somewhat lower levels than 1971. An estimated 24 million board feet of Douglas-fir sawtimber was destroyed by this insect in 1972. Intensive salvage efforts by private industry, Idaho Department of Public Lands, and Federal agencies resulted in a harvest of 36 million board feet of Douglas-fir sawtimber killed by this insect in 1970 and 1971. Low brood densities and a high ratio of unsuccessful attacks indicate that this outbreak may decline further in 1973.

Biological evaluations of the Douglas-fir beetle outbreak in the North Fork Clearwater River with personnel of the Northern Region, University of Idaho, Intermountain Forest and Range Experiment Station, and Idaho Department of Public Lands indicate that root rotting fungi such as *Poria weirii* Murr. may be a significant factor in predisposing mature and overmature trees to attack by Douglas-fir beetle.

This Douglas-fir beetle epidemic served as one of several test sites to evaluate the pheromone, Methylcyclohexenone (MCH) which apparently repels attacking Douglas-fir beetles. This test is being conducted by entomologists of the Intermountain Forest and Range Experiment Station with personnel from the Northern Region and Idaho Department of Public Lands participating (Fig. 6 and 7).

Localized areas of Douglas-fir beetle infestation occurred on lands administered by the Bureau of Land Management in the Centennial Valley in southwestern Montana. This insect invaded and killed trees weakened by "red belt" or winter drying in the Bridger Mountains on the Gallatin National Forest in Montana. Elsewhere in the Region, populations remained at endemic levels.

Figure 6.--Deploying Methylcyclohexenone (MCH) in canisters to determine effectiveness for preventing Douglas-fir beetle attack.

Figure 7.--Counting attacks and brood of Douglas-fir beetle in tree treated with MCH.

Mountain pine beetle, *Dendroctonus ponderosae* Hopk.--Infestations continued in western white pine stands on the South Fork Salmo River drainage, Colville National Forest in Washington, and portions of the Kaniksu National Forest in Idaho. Heavy losses occurred in western white pine stands on portions of the Clearwater and St. Joe National Forests and adjoining State and private lands in northern Idaho where this insect is associated with trees weakened by white pine blister rust. Estimated annual loss exceeds 200 million board feet.

Young second-growth ponderosa pine stands in Ninemile Creek west of Missoula, Montana, on the Lolo National Forest and adjoining State and private lands sustained epidemic mountain pine beetle populations for the third consecutive year. Heaviest losses are concentrated in dense, overstocked stands. Thinning operations are being evaluated as a means of cultural control in these stands. This procedure has been very successful in portions of Washington and Oregon. First year results indicate that thinning has a great deal of potential in reducing incidence of mountain pine beetle attack in dense young ponderosa pine stands in western Montana.

Epidemic mountain pine beetle populations continue in lodgepole pine stands on the Gallatin National Forest in Montana and in Yellowstone National Park in Wyoming. The forefront of the infestation in Yellowstone National Park has advanced northward to the Old Faithful Geyser Basin. Lodgepole pines in or near developed sites within this area are being killed. Localized mountain pine beetle activity was reported in lodgepole pine stands near Cliff Lake on the Beaverhead National Forest in southwestern Montana. The outbreak in mixed ponderosa-lodgepole pine stands on the Lincoln District of the Helena National Forest, Montana, continued for the fourth consecutive year in spite of control efforts which consisted of felling and burning infested trees. An outbreak in lodgepole pine stands near St. Regis, Montana, intensified on State of Montana lands along the Clark Fork River. Localized mountain pine beetle activity occurred in ponderosa pine stands on the Northern Cheyenne Indian Reservation near Lame Deer, Montana.

Pine engraver beetles, *Ips* spp.--Infestations of pine engraver beetle decreased from 1971 throughout most of the Region. In most instances, localized group killing was associated with logging operations, road building, or other construction sites. Some hot spots occurred in the Garnet Range east of Missoula, Montana, on Bureau of Indian Affairs lands southeast of Big Arm near Ronan, on private lands in the Buffalo drainage south of Helena, Montana; and in the Stranger Creek drainage on the Colville National Forest, Washington.

Infestations of the six-spined engraver association with pine looper infestations decreased to a low level in ponderosa pine stands on the Northern Cheyenne Indian Reservation in southeastern Montana.

Ips pini populations associated with mountain pine beetle continue to deplete lodgepole pine stands near St. Regis, Montana, Lolo National Forest, and second-growth ponderosa pine stands on the Ninemile Ranger District, Lolo National Forest, Montana.

MISCELLANEOUS INSECTS

A survey of 96 shelterbelts was conducted in North Dakota to determine the distribution of the ash borer, *Podosesia syringae fraxini* Luggar, and the carpenterworm *Prionoxystus robiniae* (Peck) (Fig. 8).

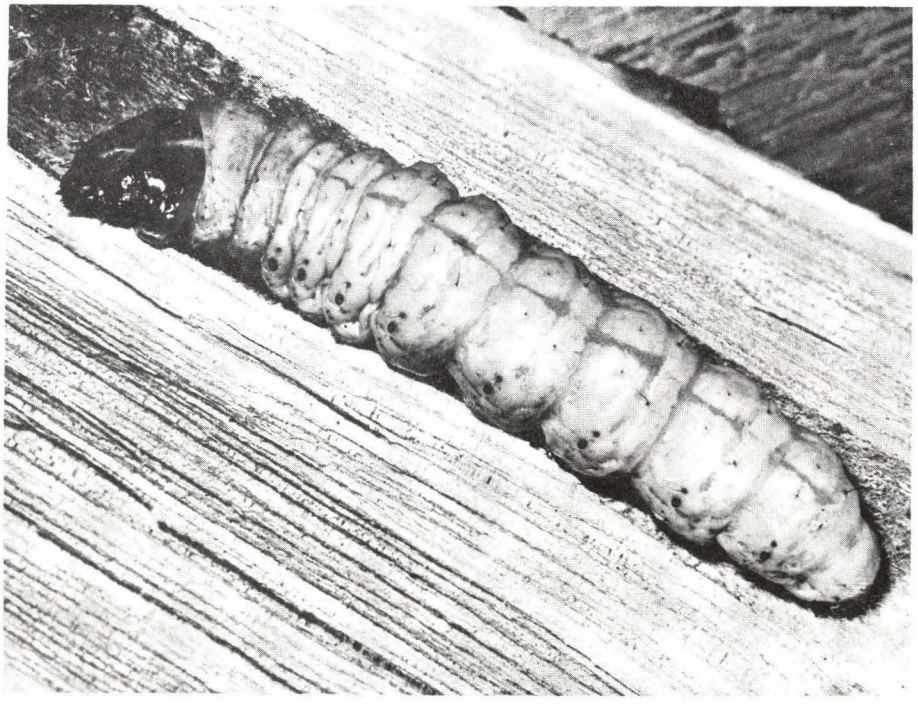


Figure 8.--Carpenterworm larva tunneling in a hardwood stem. Photo courtesy of Rocky Mountain Forest and Range Experiment Station.

It was found that 51 percent of the shelterbelts examined were infested with ash borers and 28 percent with carpenterworms. These insects weaken the main stems, resulting in excessive windbreakage or tree mortality (Fig. 9).

Figure 9.--Entrance holes and tunnels of the carpenterworm.

STATUS OF FOREST DISEASES

CONDITIONS IN BRIEF

Dwarf mistletoe lost the battle of the budget in 1972; our control funds were withdrawn to fight the southern pine beetle in southeastern United States. In a nursery disease study, we found only a 50 percent survival of outplanted seedlings after 2 years. Root rots in pole and young sawtimber stands, and stem decays in overmature stands are causing management problems. Several needle fungi caused defoliation in local areas. North Dakota land managers are concerned with hardwood cankers in shelterbelts. Fluorides and sulfur oxides are implicated in tree, shrub, and grass injury.

INTRODUCTION

Nationwide, forest diseases have an annual growth impact of about 400 million cubic feet. This is enough lumber to build 233,000 average homes. Demand for forest products is increasing, while the number of acres we can use to grow trees on is decreasing. This means grow more trees on less acres, and reducing disease losses is one way to accomplish the job.

This report is a summary of conditions either reported by Forest and State personnel or seen by us in the field.

CONIFER DISEASES

Dwarf Mistletoes

Dwarf mistletoes (*Arceuthobium* spp.) cause reduction in diameter and height growth and some mortality. Because dwarf mistletoe is destroyed by removal of infected hosts, sanitation can be incorporated into silvicultural prescriptions at little extra cost.

The silvicultural control program for dwarf mistletoe was severely limited in 1972 when all control funds were withdrawn and transferred to the Southeastern Area for control of southern pine beetle. However, some control was accomplished on several Forests by using other funding.

One crossover infection of the lodgepole pine dwarf mistletoe (*A. americanum* Nutt. ex Engel.) was found on whitebark pine on Cliff Lake Bench, Beaverhead National Forest, Montana.

An infested stand of lodgepole pine was found on the Rocky Boy's Indian Reservation in north central Montana. This extends the known distribution of lodgepole pine dwarf mistletoe in Montana.

Nursery Diseases

A study to determine survival and height growth of nursery seedlings infected with root disease fungi (primarily *Fusarium* spp.) and produced at the Forest Service nursery, Coeur d'Alene, Idaho, was established in 1970. Seedlings were outplanted on a good site near St. Regis, Montana. By fall of 1972, only 50 percent of the seedlings originally classified as "acceptable" for outplanting had survived. Height growth was not significantly affected in the surviving seedlings.

This study indicated that a very serious soil problem exists at the nursery. A special advisory board has been established which will direct a cultural program to resolve the current problems and prevent future losses.

Root Diseases

Major root rot areas are in eastern Washington, northern Idaho, and northwestern Montana (Fig. 10).

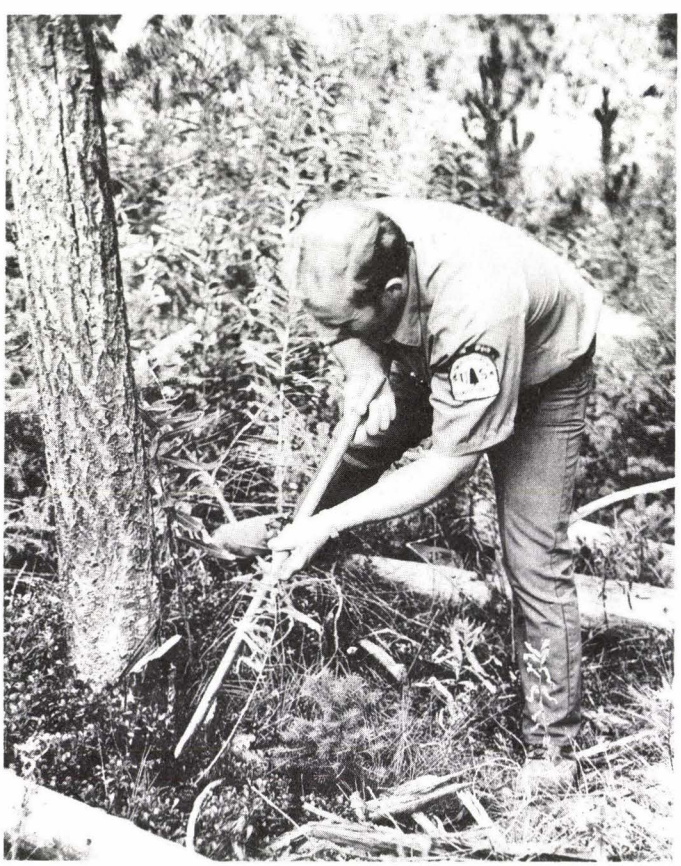


Figure 10.--Checking for root rot of Douglas-fir.

Minor root rot problems exist on east side Forests. Root diseases persist for many years and do not rapidly change from year to year. Conditions mentioned here are primarily those found in new areas although some reference is made to areas mentioned in the 1971 report.

Armillaria mellea (Vahl ex Fr.) Kummer has been found in most forested areas and on all species examined. Several large areas on the Lolo and Kaniksu National Forests were sustaining losses from *A. mellea* in mature subalpine fir and Douglas-fir, and in pole size ponderosa pine.

Poria weirii Murr. has been found on Douglas-fir, western redcedar, ponderosa pine, western white pine, and western hemlock. It is more common on the first three hosts. The fungus is frequently found on the Coeur d'Alene National Forest and, to a lesser extent, on the Kaniksu and St. Joe National Forests bordering the Coeur d' Alene. On the Kaniksu, the fungus was found causing mortality as far north as Binarch Creek, and on the St. Joe, as far south as Elk River. The fungus is most abundant on habitat types where Douglas-fir and grand fir are the major climax species. *P. weirii* is apparently coextensive with western redcedar as a butt rot.

Fomes annosus (Fr.) Cke. has been found as a root rot in young ponderosa pine plantations on the Colville National Forest and in young western redcedar on the Clearwater National Forest. The fungus has been found as a butt rot in subalpine fir on the Coeur d'Alene National Forest and grand fir on the Clearwater National Forest. Annosus root rot has not been found frequently enough to identify it with any habitat type.

Polyporus schweinitzii Fr. sporophores have been found in most areas in the habitat types where Douglas-fir, grand fir, and western hemlock are the dominant climax species. Butt and root rots have been found in abundance in mature western white pine and Douglas-fir on several areas of the Clearwater and St. Joe National Forests.

Verticicladiella sp., *Poria subacida* (Pk.) Sacc., *Polyporus anceps* Pk., and *P. tomentosus* Fr. occur in the Region, but their frequency and distribution are unknown.

Preliminary studies with aerial infrared photography show that root rot centers in some locations can be identified from photographs taken at scales of 1:1,200, 1:4,000, and 1:8,000 (Fig. 11 and 12). The use of low-level infrared photography to determine extent of root rot infection in individual centers will be evaluated in 1973. If photography can identify trees in incipient stages of infection, guidelines will be available to help the manager determine which trees should be cut in salvage and thinning operations.

Although sufficient sampling has not been done, there appears to be a strong correlation between Douglas-fir beetle (*Dendroctonus pseudotsugae* Hopkins) activity and root rots.

Figure 11.--*Poria weirii* root rot centers appear from the air as "holes" in the forest canopy. Arrows point to more obvious "holes." (Scale: approximately 1:5,000.)

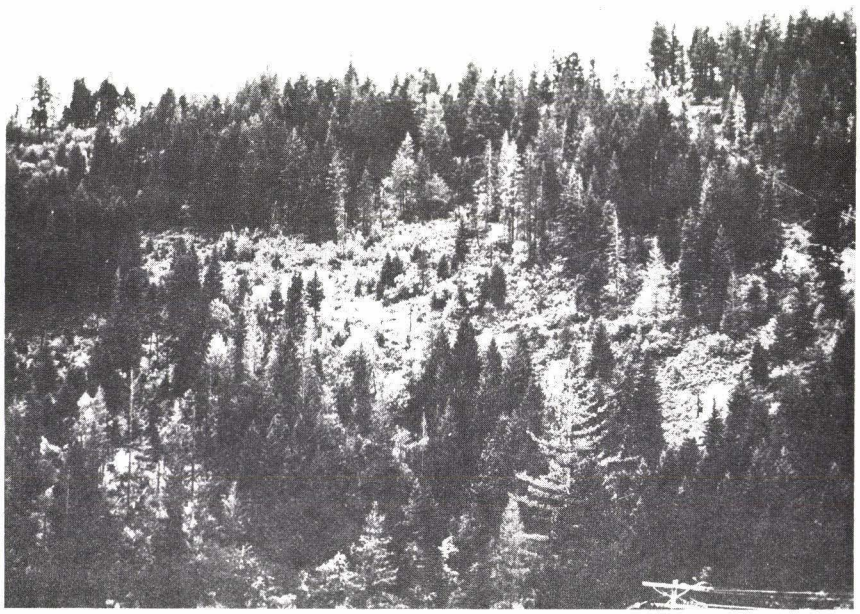


Figure 12.--*Poria weirii* root rot center from ground level. This would show up as a "hole" on an aerial photograph. Note trees are in all stages of decline.

STEM DISEASES

Decay

Decay of heartwood and/or sapwood results in cull and nonutilization, but is seldom the primary cause of mortality.

Fomes pini (Thore ex Fr.) Karst. is common in overmature stands of all coniferous species.

Echinodontium tinctorium (Ell. and Ev.) Ell. and Ev. causes a high degree of cull in mature and overmature grand fir and western hemlock.

Other stem decay fungi of importance are *Stereum sanguinolentum* (Alb. and Schw. ex Fr.) Fr., *Polyporus sericeomollis* Rom., *P. sulphureus* Bull. ex Fr., *Hydnum abietis* Hubert, and *Fomes officinalis* (Vill.) Faull.

Cankers and Galls

Symptoms of canker activity are yellowing and reddening of whole portions of the tree distal to the canker. Top dieback is common in larger trees; mortality often occurs in smaller trees.

Cytospora spp. and/or *Phomopsis pseudotsuga* M. Wilson caused conspicuous flagging on true firs in most areas. Basal wounds associated with snow damaged Douglas-fir seedlings from the Nezperce National Forest were colonized by these fungi. The fungi completed the girdling and resulted in seedling mortality.

Atropellis piniphila (Weir) Lohman and Cash was found causing branch and bole cankers of lodgepole pine throughout the Region.

White pine blister rust (*Cronartium ribicola* J. C. Fisch.), in conjunction with mountain pine beetle (*Dendroctonus ponderosae* Hopkins), is causing considerable mortality throughout the western white pine areas.

Western gall rust (*Endocronartium harknessii* (J. P. Moore) Hiratsuka) is common wherever lodgepole and ponderosa pine is found. Some mortality occurs in young trees.

FOLIAGE DISEASES

Needle Cast

This disease of conifers, caused by a number of closely related fungi, is widespread. The most characteristic symptom is a red or brown discoloration of foliage. Severe infection causes a reduction in growth and predisposes trees to attack by other diseases and insects.

Elytroderma deformans (Weir) Darker (Fig. 13) caused extensive damage in the Flathead and Bitter Root Valleys. In conjunction with the pine butterfly (*Neophasia menapia* (Felder and Felder)), infection resulted in some mortality in pole size ponderosa pine in the Bitter Root Valley.

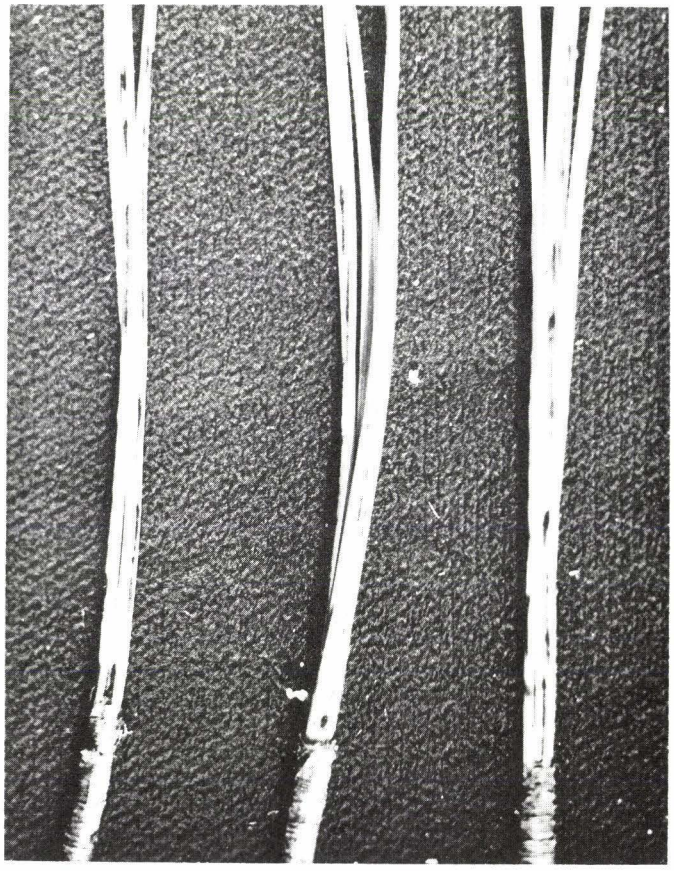


Figure 13.--Characteristic elongate, black fruiting bodies of *Elytroderma deformans* on ponderosa pine needles.

Lophodermium pinastri (Schrade. ex Hook.) Chev. caused severe defoliation in several young ponderosa pine stands on the St. Joe and Kaniksu National Forests.

Lophodermella arcuata (Darker) Darker caused considerable defoliation of western white pine in northern Idaho.

Needle Rusts

Needle rusts are most important on seedlings and saplings, but since only a small portion of the needles are affected and the rusts vary in severity from year to year, trees are seldom killed.

Pucciniastrum goeppertianum (Kuehn) Kleb. and/or *P. epilobii* Otth. were found on grand fir seedlings on west side Forests, but damage was not significant.

Fir broom rust (*Melampsorella caryophyllacearum* Schroet.) was abundant on subalpine fir at higher elevations.

Spruce broom rust (*Chrysomyxa arctostaphyli* Diet) was abundant on Engelmann spruce, particularly on east side Forests.

Other Needle Diseases

Douglas-fir needle blight, caused by *Rhabdocline pseudotsugae* Syd., was locally severe on Douglas-fir in northern Idaho and northwestern Montana.

Dothistroma pini Hulb., causing "red band" disease of ponderosa pine, caused defoliation of young trees in the lower Lochsa River and Priest River areas.

HARDWOOD DISEASES

Tubercularia sp., *Cytospora* sp., *Fusarium* sp., *Camarosporium* sp., and a *Dothichiza*-like fungus were found fruiting on cankers of Siberian elm, Russian olive, willow, white poplar, and boxelder in shelterbelt and highway plantings in North Dakota (Fig. 14).

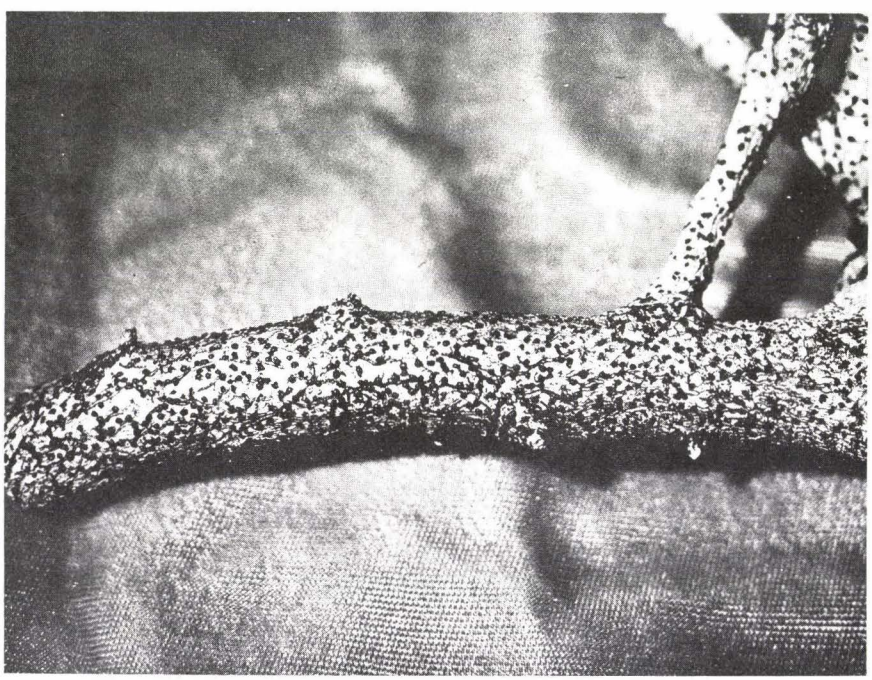


Figure 14.--Canker of Siberian elm from North Dakota shelterbelt planting. The small, black spots are are fruiting bodies of *Tubercularia* sp.

Many of the cankers were associated with mechanical injuries, but pathogenicity of each of the fungi has not been established. Studies will continue in 1973.

Herbicide damage was noted on many hardwood species in North Dakota shelterbelts.

Dutch elm disease, caused by *Ceratocystis ulmi* (Buis.) C. Moreau, occurs in the Bismarck-Mandan area of North Dakota. The disease may occur in other locations in North Dakota, but has not yet been detected.

One unconfirmed case of Verticillium wilt of American elm, caused by *Verticillium albo-atrum* Reinke and Berth., was reported in Billings, Montana.

AIR POLLUTION

Fluoride damage to vegetation was evaluated in two areas: near the Anaconda Aluminum Company plant in Columbia Falls, Montana, and near a phosphorous producing plant near Butte, Montana.

In the Columbia Falls study area, injury in the form of terminal dieback, needle tip necrosis of conifers and marginal necrosis of broadleaf plants was detected up to 5 air miles from the aluminum plant. Severity of injury was similar to that observed in 1971.

In the Butte study area, excessive foliar concentrations (greater than 10 parts per million, dry weight basis) of fluoride were found up to 6 air miles from the phosphorous plant. One area currently being used for livestock grazing (located within one-half mile of the plant) had grasses containing up to 70 parts per million fluoride. This is twice the amount allowed in forage crops by Montana law.

A large copper smelter at Anaconda, Montana, and lead and zinc smelters at Kellogg Idaho (Fig. 15), emit large quantities of sulfur oxides into the atmosphere. Studies designed to measure atmospheric concentrations of sulfur dioxide and sulfur dioxide injury to indigenous vegetation were established in both areas in 1972. Preliminary results indicate that acute and chronic sulfur dioxide-like injury has occurred on vegetation at several locations around both areas and that atomospheric concentrations of sulfur dioxide are high enough to cause injury (Fig. 16).

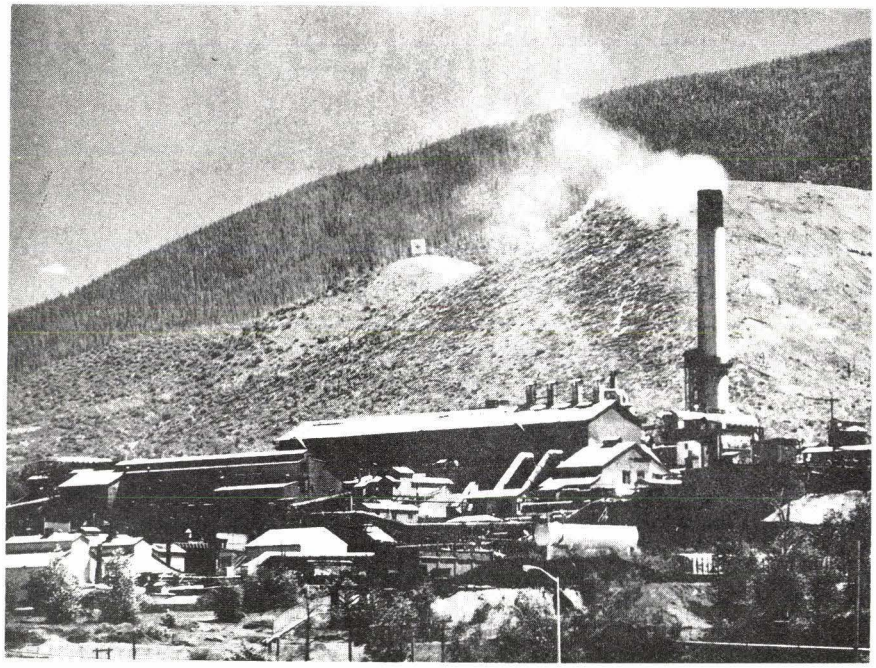


Figure 15.--Lead smelter at Kellogg, Idaho. Sulfur dioxide emitted from this smelter since the early 1900's has killed and injured a large amount of vegetation in the area. High amounts of lead, cadmium, and zinc have also been deposited in the soils.

Figure 16.--Visible air pollution caused by the lead and zinc smelters at Kellogg, Idaho. Sulfur dioxide and water vapor are the major components. The extent of visible injury to vegetation nearly coincides with the limits of visible pollution.